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Bacteriology - Embryology - Hygiene

Study Outlines

SECTION I

BACTERIOLOGY

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CHAPTER I

BACTERIA

I. DEFINITIONS.

A. Bacteriology.

Bacteriology is the science which treats of bacteria.

B. Bacteria.

Bacteria are microscopic, unicellular organisms which reproduce by fission or cleavage. They are classified as fission fungi or schizomycetes.

II. CLASSIFICATION.

A. Bacillus (pl. bacilli).

Rod-shaped organisms, assuming various arrangements.

B. Coccus (pl. cocci).

Spherical in shape. They are classified according to their arrangement:-

1. Micrococcus - occurring singly.
2. Diplococcus - occurring in pairs.
3. Staphylococcus - occurring in bunches.
4. Streptococcus - occurring in chains.
5. Tetrads - occurring in groups of four.
6. Sarcina - occurring in cubical packets.

C. Spirillum (pl. spirilli).

Spiral-shaped organisms.

D. Vibrione (pl. vibrio).

Comma-shaped organisms.

III. STRUCTURE AND CHARACTERISTICS.

Bacteria consist of protoplasm which is thickened at the periphery to form a cell wall.

Their chemical composition varies and is dependent upon their nutrition; but the following will do as an average: water 75% to 85%; protein 5% to 25: fats 1% to 2%; and ash 1% to 2%. Chlorophyl is not found.

Some bacteria are surrounded by a waxy capsule which requires special staining methods.

Some bacteria are motile, either by undulatory movements or by thread-like projections called flagella (sing: flagellum).

IV. SPORULATION.

Under unfavorable conditions certain bacteria form spores for their preservation. First there is a granular appearance of the protoplasm. Finally the granules coalesce and form a refractile body in one part of the cell. This is the spore and it is much more resistant to germicides than is the organism in its active state.

V. LIFE CYCLE AND REPRODUCTION.

In fullest activity the life of a single organism is very short. An example, the B. Coli Communis, lives from 16 to 20 minutes. A. Fisher estimates, that under ideal conditions 1,600,000,000,000,000 bacilli would develop from a single organism in 24 hours.

Most bacteria flourish at body temperature.

CHAPTER II

KINDS OF BACTERIA

I. OBLIGATE AEROBIC BACTERIA.

Those that thrive only in the presence of oxygen.

II. OBLIGATE ANAEROBIC BACTERIA.

Those that thrive only in the absence of oxygen.

[NOTE: Some organisms can adapt themselves to either environment and these are said to be facultative aerobes or anaerobes.]

III. SAPROPHYTIC BACTERIA.

Saprophytes live on dead animal and vegetable matter, splitting it into simpler compounds, liberating water, ammonia, carbonic acid and ptomains. Very few of the saprophytes survive in living animal bodies. However, by living upon the dead cells in a living body, they break the former down into simple compounds which are irritant to adjacent living cells, injuring them and impairing their function, and thus allowing a point of entrance for pathogenic bacteria.

When saprophytic bacteria gain entrance into food products they may produce chemical changes resulting in toxic compounds.

IV. PARASITIC BACTERIA.

Those directly causing disease. Some of them are solely parasitic; others are facultatively parasites or saprophytes.

CHAPTER III

LABORATORY PROCEDURES

I. MICROSCOPY.

An oil immersion objective of 1/12 power is necessary for viewing bacteria, since the unit of measurement is 1 micron (1/25,000 of an inch). Specimens are prepared upon a cover glass and slide and stained, before observation.

II. STAINING BACTERIA.

Bacteria are almost, or are entirely, invisible unless stained. There is a variety of stains used such as: Loeffler's Methylene Blue; Fuchsin; Gentian Violet; and Eosin. Grams Stain is a useful differential stain which enables the observer to classify bacteria in one of two groups. If the specimen retains the deep purple, it is known as a Gram positive organism (Gram +). If the specimen remains colorless it is known as a Gram negative organism (Gram -).

Most of the common cocci are Gram positive, with the following exceptions:- Gonococcus; Meningococcus; M. Catarrhalis; M. Melitensis.

The following bacilli are Gram positive. B. Diphtheria; B. Pseudodipth; B. Xerosis; B. Tuberculosis; B. Leprae; B. Tetanus; B. AerogenesCapsulatus; B. Anthracis; B. Botulinus; B. Subtilis. Most of the other bacilli are Gram negative.

The spirilli are Gram negative.

The higher bacteria are Gram negative.

Other less common or special stains are Anilin Water; Anilin Gentian Violet; Neisser's; Neisser's Acid Methylene Blue; Bismarck Brown; Carbol Fuchsin; Pappenheim's Solution; Gabbet's Solution; McCrories' Flagella Stain; Muir's; Capsule Mordant (Muir's Method); Special Carbol Fuchsin for Staining Spores.

III. STERILIZATION.

This is the removal from, or destruction of, microorganisms in, or upon, matter. It is accomplished by filtration, chemicals, heat and gases.

Following are some of the chemical agents used in sterilizing and disinfecting: Bichloride of Mercury; H_2O_2; Permanganate of Potash; Silver Salts; Iodine; Chlorine; Chloride of Lime; Ethyl Alcohol; Coal Tar Substances; Phenol; Creosol; Lysol; Creolin; Formaldehyde; Iodoform.

Sterilization by heat is accomplished by direct fire, hot air, boiling, or steam.

IV. CULTURE MEDIA.

These are fluid or solid materials upon which bacteria are cultivated in the laboratory for study. They are divided into two classes, as follows:

A. Natural Culture Media.

Fluid	Solids
Milk	Blood serum (coagulated)
Whey	Eggs
Blood serum	Potatoes
Serous fluids	
Eggs	
Ox bile	
Urine	

B. Artificial Culture Media.

Fluid	Solid
Bouillon (Also made up with the addition of various types of sugar, ox-bile, etc.)	Agar (Also made up with the addition of various types of sugar, glycerin, blood, etc.)
Peptone Solutions	Gelatin
Bile salt solutions	

Most bacteria grow best on a slightly alkaline media. It is important that reaction of the media be corrected.

CHAPTER IV

STAPHYLOCOCCI

I. HABITAT.

Air, dust, soil, mouth and intestines of both healthy and unhealthy people. Almost always on the hands and scalp, and foodstuffs.

There are many saprophytic and pathogenic species.

The staphylococci cause a large part of the infections in man and the following types cause most of the infections of that group. They are chromogenic.

(a) Staphylococcus pyogenes Albus (white pigment)
(b) Staphylococcus pyogenes Aureus (yellow pigment)
(c) Staphylococcus pyogenes Citreus (greenish pigment)

II. MORPHOLOGY.

Spherical, unicellular organisms, 0.5 to 1.0 u in diameter.

Arrangement: in bunches, large or small.

III. MOTILITY.

Brownian movement in hanging-drop preparations.

IV. STAINING.

Take all anilin dyes. Gram positive.

V. CULTURE.

Aerobic and facultative anaerobic. Grow between 10° C and 40° C; best at 37° C. All media are suitable for growth, but best if the media are slightly alkaline.

VI. RESISTANCE.

Live for months on culture media. In dried state they live for weeks or months. Repeated freezing does not kill them. Boiling kills them instantly.

VII. TOXIN.

Produce an intracellular toxin which is destructive to white and red blood cells.

VIII. PATHOGENESIS.

The staphylococci exhibit various degrees of virulence. Most of the infections occurring after wounds and operations are caused by the staphylococci. They produce most of the boils and abscesses. This is particularly true of the staphylococcus pyogenes aureus. They may cause local or widespread infections. Sometimes they are the offenders in:-

Rhinitis	Pharyngitis
Otitis	Bronchitis
Coryza	Pneumonia
Pleurisy	Endocarditis
Synovitis	Enteritis
Nephritis	Cystitis
Urethritis	Meningitis

Man is more susceptible to staphylococcic infections than are the lower animals.

IX. BIOLOGIC THERAPY.

Bacterial vaccines of the organisms are used to increase immunity or limit the infections.

CHAPTER V.

STREPTOCOCCI

I. HABITAT.

Air, soil, water, stable refuse and occasionally on the skin and in the mouth of healthy people.

II. MORPHOLOGY.

Spherical, unicellular organisms from 0.5 to 1.0 u in diameter, arranged in long or short chains.

III. MOTILITY.

None.

IV. STAINING.

Readily stained with anilin stains, and are Gram positive.

V. CULTURE.

Grow fairly well on ordinary culture media. Grow best on media containing blood serum or ascitic fluid. Media may be slightly acid, neutral or slightly alkaline in reaction. The optimum temperature for growth is 37° C. Grows slowly between 15°C and 44°C.

VI. RESISTANCE.

In cultures, streptococci are reduced in virulence and die in a few days or weeks. Boiling kills them instantly; hot air at 120°C in 30 minutes; and moist air at 60°C in 30 to 60 minutes. They are not very resistant to germicidal agents.

VII. TOXIN.

They produce an intracellular toxin.

VIII. BIOLOGIC THERAPY.

The anti-sera are fairly successful. Bacterial vaccines are used to combat infection and raise the resistance of the patient.

IX. PATHOGENESIS.

There is a considerable variance in the virulence of different strains. The virulence is increased by passage thru man and animals.

The organism may be the exciting cause of disease or a secondary invader.

Localized streptococcic lesions show a greater area of inflammation and edema than do staphylococci lesions, and the pus is more serous in character.

The following diseases may be due to streptococci: broncho-pneumonia, meningitis, angina pectoris, erysipelas and puerperal septicaemia.

Strept - hemolyticus.
dissolves red blood cells.

S - pyogenes.
pus producing

CHAPTER VI

PNEUMOCOCCUS
(Diplococcus lanceolatus)

I. HABITAT.

Occurs in nose and mouth of healthy people and in sputum of those harboring the organisms.

II. MORPHOLOGY.

Occur in pairs, somewhat oval in shape, with the rounder ends in apposition. Each pair is surrounded by a capsule. The pairs often occur in short chains, varying in size.

III. STAINING.

With the anilin stains. Gram positive. The capsule requires special staining to demonstrate it.

IV. CULTURE.

Very much like the streptococci.

V. RESISTANCE.

In masses of sputum, may retain its virulence for a long time. It is easily destroyed by chemicals. Hot air at 120°C kills it in 30 minutes. Steam kills it in 30 minutes or less at 55°C to 60°C.

VI. TOXIN.

Produces an intracellular toxin. An antitoxin can be prepared to neutralize it.

VII. PATHOGENESIS.

Virulence increases by passage thru animals.

It is said to be the offender in 90% of the cases of lobar pneumonia and 50 to 80% of all other forms of pneumonia.

It often causes otitis media, rhinitis, ozena, pleurisy, peritonitis, endocarditis, pericarditis and meningitis.

If the organism is present in the lacrimal se-

cretion at the time of a break in the cornea or sclera, a serious infection often develops.

VIII. TYPES.

From the standpoint of preparing an anti-serum, four types of the organism are recognized, each of which produces its peculiar toxin. Bacterial vaccines usually contain the four types.

CHAPTER VII

GONOCOCCUS
(Neisser's coccus)

I. HABITAT.

Genito-urinary tract. In organs of affected persons. Not found outside the human body. Infects man only.

II. MORPHOLOGY.

Occurs in pairs. Ovoid in shape with flat sides in apposition. Length 0.6 to 0.8 u.

III. STAINING.

With anilin dyes. Gram negative.

IV. CULTURE.

Requires special media.

V. RESISTANCE.

Delicate organism. Dies in a few hours in dried pus. Can live between 0°C and 37°C. Above 40°C it is injured. Moist heat at 60°C for 10 or 15 minutes kills it. High dilutions of chemicals rapidly kill it. It is especially sensitive to silver salts.

VI. TOXIN.

It produces an intracellular toxin.

VII. BIOLOGIC THERAPY.

Bacterial vaccines are of value in subacute and chronic infections; but not in acute infections. Their chief indication is in gonococcus arthritis.

VIII. PATHOGENESIS.

It has a predilection for the urethral mucous membrane. It causes gonorrhea or specific urethritis. It may affect all of the genito-urinary organs. If the organism passes into the blood stream it causes

endocarditis, often malignant, or arthritis. Infection in nearly all cases is by direct contact with persons harboring the disease.

It may be transferred to the eye causing severe purulent inflammation. Infants during birth may have the eyes infected with the organism (ophthalmis neonatorum).

The organism may be harbored long after the disease manifestations have ceased.

CHAPTER VIII

MICROCOCCUS CATARRHALIS

I. HABITAT.

Sputum and respiratory mucous membranes.

II. MORPHOLOGY.

Same as the gonococcus.

III. STAINING.

Anilin stains. Gram negative.

IV. PATHOGENESIS.

Feebly pathogenic. May cause catarrhal inflammations. Frequently a secondary invader.

CHAPTER IX

MENINGOCOCCUS

I. HABITAT.
Nose and throat.

II. MORPHOLOGY.
Same as the gonococcus.

III. STAINING.
Anilin stains. Gram negative.

IV. PATHOGENESIS.
Meningitis; inflammations of the naso-pharynx and throat.

CHAPTER X

BACILLI

I. INFLUENZA (PFEIFFER'S).

A. Habitat.

Mouth and throat of healthy people. Saliva and sputum of influenza patients.

B. Morphology.

Rod-shaped; 0.3 to 1.5 u long. Irregularly arranged. Non-motile.

C. Staining.

Analin dyes - Gram negative.

D. Culture.

Obligate aerobe. Grows best on blood smeared agar, at body temperature.

E. Resistance.

Dies quickly outside the body. May survive for some time in sputum. Readily killed by weak germicidal solutions and moist heat at 50°C.

F. Pathogenesis.

Is the exciting cause in some cases of coryza, influenza, pneumonia and meningitis.

II. KOCH-WEEKS.

A. Characteristics.

Same as B. Influenza.

B. Pathogenesis.

Cause of acute contagious conjunctivitis or "pink-eye". It is found on the conjunctiva and in the lacrimal discharge.

III. BORDET-GENGOUS

A. Habitat.

Occurs in bronchial mucous and sputum of some pertussis cases.

B. Characteristics.

Same as B. Influenza, but oval in shape. Gram negative.

IV. MORAX AND OXENFELD.

A. Habitat.

Conjunctival exudate or pus.

B. Morphology.

A diplobacillus: 2 to 3 u long.

C. Staining.

Anilin stains. Gram negative.

D. Resistance.

Low: Easily destroyed by heat.

E. Pathogenesis.

Causes subacute or chronic catarrhal conjunctivitis.

CHAPTER XI.

DIPHTHERIA BACILLUS
(Klebs-Loeffler Bacillus)

I. HABITAT.

Air; dust; furniture and drapery of rooms inhabited by diphtheria patients and carriers. Found also, it has been stated, on dogs, cats and cows, associated with diphtheria patients or carriers.

II. MORPHOLOGY.

A rod-shaped organism showing great variations in size and form. They range in length from 0.3 to 7.0 u. Nineteen different types are recognized.

III. STAINING.

Anilin stains and special stains. Gram positive.

IV. CULTURE.

Aerobic. Grows best at 37°C. Grows on most media, but best on veal bouillon and Loeffler's blood serum.

V. RESISTANCE.

Easily destroyed. Moist heat kills at 60°C, in 15 minutes. It is sensitive to chemical germicides.

VI. TOXIN.

Produces a potent extracellular toxin.

VII. PATHOGENESIS.

Has a selective affinity for the mucous membranes of the human body, especially those of the upper respiratory tract. It causes the disease of diphtheria.

VIII. BIOLOGIC THERAPY.

By anti-serum (or diphtheria anti-toxin)

CHAPTER XII

TUBERCLE BACILLUS

I. HABITAT.

Air; dust; soil; water; discharges from affected persons; and milk products.

II. MORPHOLOGY.

Small, straight or curved rods, 1.5 to 4.0 u long, arranged singly or in clumps.

III. STAINING.

The organism has a fatty capsule; hence ordinary anilin stains do not stain it. When stained with carbol fuchsin, neither acid nor alcohol decolorizes it. A special staining method, (including the use of carbol-fuchsin), colors it red, and the rest of the field blue. The organism is Gram positive.

IV. CULTURE.

Grows best at 37°C. It grows only on blood-serum or on media to which blood, blood serum, tissue or glycerine has been added. It grows very slowly.

V. RESISTANCE.

Greatest in the tissues of the body. It resists drying and retains its virulence in both dried and moist states. It requires 1/2 hour of boiling, or several hours of dry heat at 150°C, to destroy it. It is difficult to destroy with germicides.

VI. TOXIN.

Produces a potent extra-cellular and intra-cellular toxin. The intra-cellular toxin is known as tuberculin, which is used as a diagnostic aid.

VII. PATHOGENESIS.

The disease tuberculosis may be localized in any part of the body, or by metastasis, may become

generalized. Pulmonary tuberculosis, with or without other parts of the body affected, is the most common form in man.

CHAPTER XIII.

COLON BACILLUS
(Bacillus Coli Communis)

I. HABITAT.

Normally found in the intestinal tract of man and animals. A large part of the feces is composed of colon bacilli. The organism has been found on plants and in water in regions where no animal life was present. Occurs in air; dust; soil; and water, polluted by sewage. Food-stuffs can be contaminated from these sources.

II. MORPHOLOGY.

Straight, round-end bacillus; 2 to 4 u long. Has 4 to 8 flagella and is actively motile.

III. STAINING.

Anilin stains. Gram negative.

IV. CULTURE.

Aerobic and facultatively anaerobic. Grows best at 37°C. Grows on all ordinary media.

V. RESISTANCE.

Not killed by freezing. Instantly killed by boiling. Steam kills it at 60°C., in 30 minutes. In a dried state it may live for 6 months. Direct sunlight kills it in 4 to 30 hours. Not very resistant to chemical germicides.

VI. TOXIN.

Produces an intracellular toxin.

VII. PATHOGENESIS.

Some strains are virulent and may cause septicemia. They may attack any of the abdominal organs.

Food-stuffs may become contaminated with colon bacilli and cause poisoning.

CHAPTER XIV

TREPONEMA PALLIDUM

I. HABITAT.

Lesions in syphilis; at times in the blood; and in affected organs.

II. MORPHOLOGY.

Average, 6 u in length; spiral shaped, showing from 5 to 20 curves. The end is pointed and terminates in a single flagellum. The organism is actively motile with a screw-like motion.

III. STAINING.

Requires special stains, the organism appearing black.

IV. CULTURE.

Difficult on artificial media.

V. RESISTANCE.

Susceptible to mercury and salvarsan. Moderate degrees of heat kill it. Resists drying for a short time.

VI. PATHOGENESIS.

Occurs in man only, causing syphilis (lues).

VII. DIAGNOSIS.

Wassermann test.

CHAPTER XV.

MISCELLANEOUS ORGANISMS

I. B. TYPHOSUS.

Gram negative. Causes typhoid fever. Occurs in blood and discharges of patients, from which food, soil, water and utensils may be contaminated.

Other organisms producing disease manifestations similar to typhoid fever are:-

A. Paratyphoid A. Bacillus.
B. Paratyphoid B. Bacillus.
C. Bacillus Enteritidis of Gaertner.

II. B. PROTEUS VULGARIS.

Putrefies foods.

III. B. LACTIS AEROGENES.

Chief cause of souring milk.

IV. B. BULGARICUS.

Produces the greatest amount of lactic acid in milk in the shortest time of any organism. It does not putrefy milk nor injure its food value.

V. B. BOTULINUS.

Contaminates foods, producing a powerful poison, causing death in 25% of the cases affected. Symptoms - Not less than six hours after ingestion, there are; impairment of vision; disturbance of speech; increased salivation; general muscular weakness; and sometimes paralysis.

VI. B. AEROGENES CAPSULATUS.

Causes emphysematous gangrene thru entrance at the site of an injury.

VII. B. TETANI.

Gram positive, sporulating organism found in dust, soil, and especially on farms and in cattle

sheds. Produces a powerful extracellular toxin and is the cause of tetanus (lock-jaw).

VIII. B. ANTHRACIS.

Gram-positive, spore-forming bacillus. Highly virulent. Handlers of hides, wool, or cattle, are exposed most to the infection. The disease may cause a bacteremia or localized malignant pustule (carbuncle).

IX. B. MALLEI.

Gram-negative bacillus. Causes glanders in horses and mules, which may be transmitted to man often causing death.

CHAPTER XVI.

HIGHER BACTERIA

These are placed between the bacteria and true molds. They are divided into three groups known collectively as trichomycetes.

I. LEPTOTHRICES.

Rod-shaped; varying from 30 to 150 u in length. Found in the mouth as saprophytes.

II. CLADOTHRICES.

False branched.

III. STREPTOTHRICES.

Long filaments, with true branches, having club-like terminations. The principal pathological ones are:-

A. Streptothrix Actinomycosis.

Causes lump jaw in cattle and may be transmitted to man.

B. Streptothrix Madurae.

Causes "madura foot" in man.

C. Achorion Schonleini.

Cause of tinea favosa (crusted ring-worm).

CHAPTER XV

HYPHOMYCETES
(Molds)

Widely distributed in nature. The molds have differentiated parts which may be compared with the roots, trunk and fruit of trees.

Most of them are non-pathogenic. Their resistance is higher than that of bacteria.

CHAPTER XVII

HYPHOMYCETES
(Molds)

I. Widely distributed in nature. The molds have differentiated parts which may be compared with the roots, trunk and fruit of trees.
Most of them are non-pathogenic. Their resistance is higher than that of bacteria.

II. MORPHOLOGY.

III.

CHAPTER XVII

SACCHAROMYCETES
(Blastomycetes)

I. DESCRIPTION.

These are the yeasts and are widely distributed in nature. They are the common cause of fermentation. The cultivated varieties are important in wine making, brewing and baking. A few of them are pathogenic.

II. MORPHOLOGY.

Occur as round or oval unicellular organisms, averaging 10 to 40 u in diameter. They have a distinct cell wall.

III. PATHOGENESIS.

Three types are known to be pathogenic to man, causing thrush (infants' sore mouth), dermatitis, and localized tumors or ulcerations.

SECTION II

EMBRYOLOGY

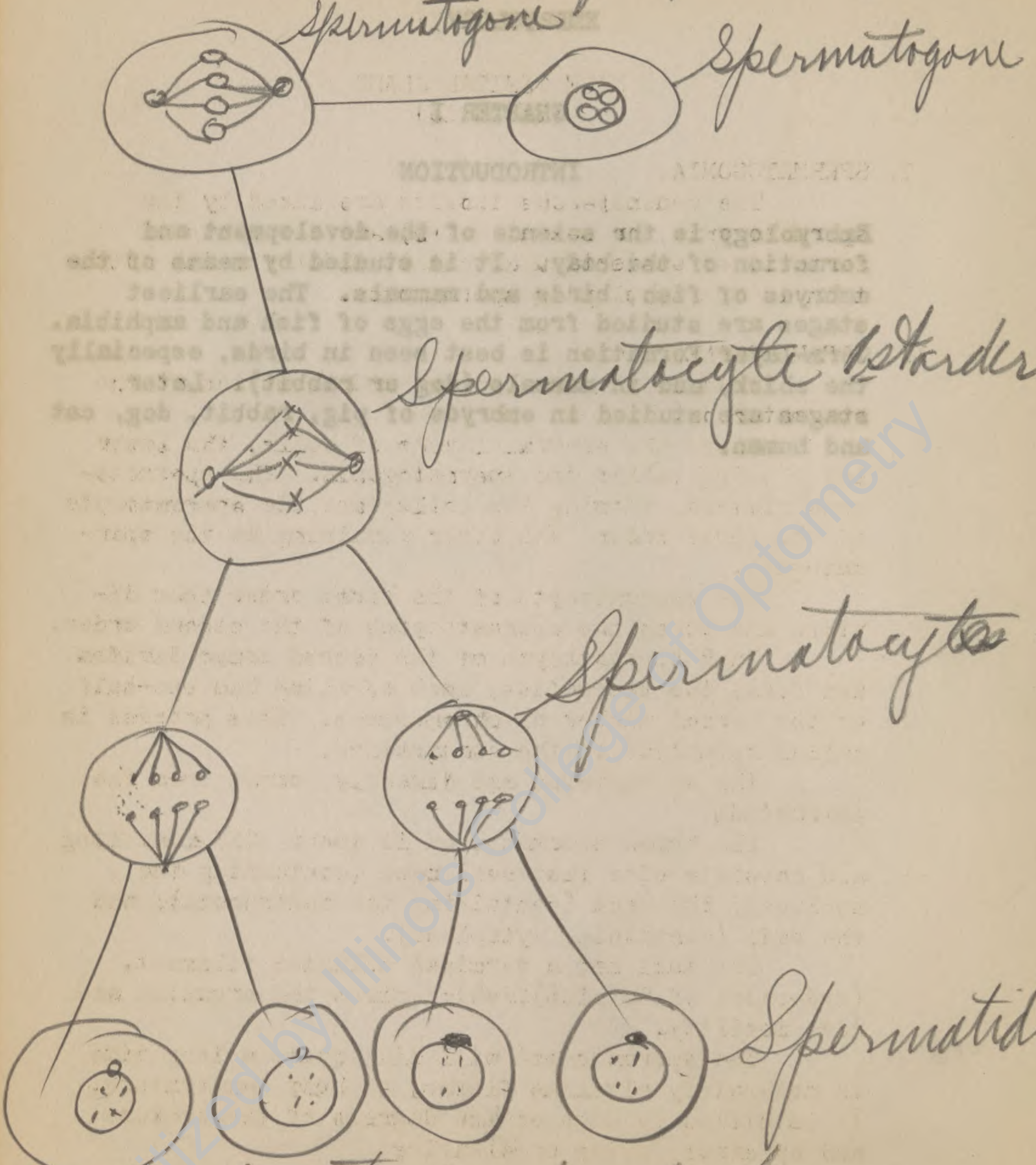
EMBRYOLOGY

CHAPTER I

INTRODUCTION

Embryology is the science of the development and formation of the body. It is studied by means of the embryos of fish, birds and mammals. The earliest stages are studied from the eggs of fish and amphibia. Germ-layer formation is best seen in birds, especially the chick, and in mammals (dog or rabbit). Later stages are studied in embryos of pig, rabbit, dog, cat and human.

Develapement of Spermatogoon.



Contains ½ of chromosome.

CHAPTER II

MALE GENITAL GLAND
(Testicle)

I. SPERMATOGONIA.

The semeniferous tubules are lined by the spermatogonia, or sexual cells, and the cells of Sertoli, or sustentacular cells, which furnish nutrition to the developing spermatozoa.

II. SPERMATOGENESIS.

This is the development and formation of the spermatozoon.

There are several layers of cells, the lower layer being called the spermatogonia. The spermatogone divides, forming two cells; one the spermatocyte of the first order, the other remaining as the spermatogone.

The spermatocyte of the first order then divides and forms two spermatocytes of the second order.

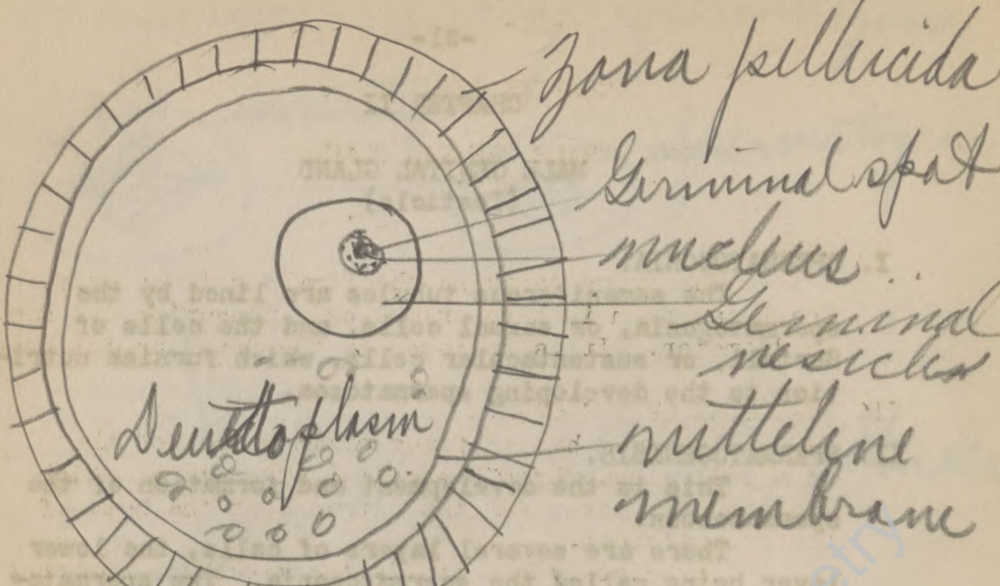
Each spermatocyte of the second order divides and forms two spermatids, each of which has one-half of the normal number of chromosomes. This process is called reduction of the chromosomes.

The spermatozoa are directly formed from the spermatids.

The human spermatozoon is about .055 m.m. long and consists of a flat oval head (containing the nucleus); the neck (containing the centrosome); and the tail (containing cytoplasm).

The tail has a terminal ciliated filament, (end-piece of Retzius), which gives the organism active motility.

The spermatozoon will live quite a long time in moderately alkaline fluids, at body temperature. It is killed by high or low degrees of temperature and by strong acids or alkalies.


Zona pellucida
Germinal spot
nucleus
Germinal vesicle
vitteline membrane
Deutoplasm

CHAPTER III

THE FEMALE GENITAL GLAND
(Ovary

I. OVUM.

The ovary contains the female cell or ovum. The human ovum is a spherical cell measuring 0.2 m.m. in diameter. It is enclosed in the Graafian follicle.

II. STRUCTURE OF THE OVUM.

The ovum has an outer membrane called the zona pellucida, which has radial striations, which are probably pores for the entrance of the head of the spermatozoon.

Immediately beneath is the vitelline membrane or true cell wall.

It encloses the cytoplasm, called the yolk or vitellus.

The vitellus is heavily charged with food-particles called deutoplasm.

A large nucleus, called the germinal vesicle, is situated in the vitellus. This vesicle has a varying amount of chromatin, depending upon the state of activity of the ovum.

A well marked nucleolus in the nucleus is called the germinal spot.

III. RIPENING OF THE GRAAFIAN FOLLICLE.

A. 1st Stage.

Consists of a single ovum surrounded by one layer of epithelial cells and a fibrous coat. The follicle grows larger and sinks toward the central part of the ovary. The number of cells increases around the ovum. From the stroma, a fibrous and vascular tunic grows around the follicle forming the Graafian Follicle, 2nd stage.

B. 2nd Stage.

Then follows a liquefaction of the cells

in the follicle, the fluid forming the liquor folliculi, in which the ovum floats, but is still joined to the wall of the follicle by a pedicle called the discus proligerus. Thus is formed the Graafian Follicle, 3rd stage.

C. 3rd Stage.

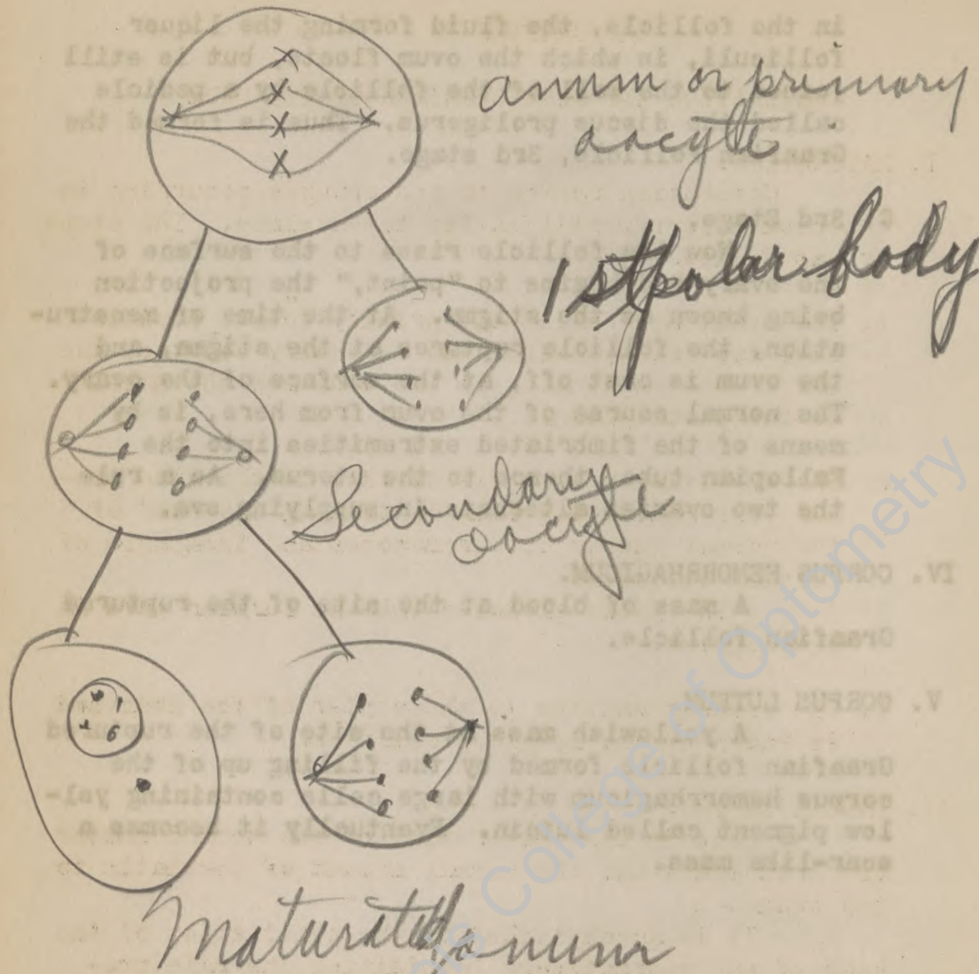
Now the follicle rises to the surface of the ovary and begins to "point," the projection being known as the stigma. At the time of menstruation, the follicle ruptures at the stigma, and the ovum is cast off, at the surface of the ovary. The normal course of the ovum from here, is by means of the fimbriated extremities into the Fallopian tube, thence to the uterus. As a rule the two ovaries alternate in supplying ova.

IV. CORPUS HEMORRHAGICUM.

A mass of blood at the site of the ruptured Graafian follicle.

V. CORPUS LUTEUM.

A yellowish mass at the site of the ruptured Graafian follicle formed by the filling up of the corpus hemorrhagicum with large cells containing yellow pigment called lutein. Eventually it becomes a scar-like mass.



ovum or primary oocyte
1st polar body
Secondary oocyte
Matured ovum

CHAPTER IV

MATURATION AND FERTILIZATION OF THE OVUM

I. MATURATION.

Maturation refers to the changes occurring in the ovum before fertilization takes place. The steps are as follows:-

A. The ovum, now called the primary oöcyte divides into two cells, called the secondary oöcytes; the larger one continuing as the ovum and the smaller as the polar globule.

B. The resulting ovum again divides in the same manner, the continuing ovum containing one-half of the normal number of chromosomes and incapable of further division.

The polar globules take no further part in development.

C. The nucleus wanders to the center of the ovum and is known as the female pronucleus.

II. FERTILIZATION.

This is the restoration of the normal number of chromosomes and the normal amount of chromatin to the ovum.

It is accomplished by the penetration of the head of one spermatozoon (containing the male pronucleus) into the ovum, and the blending of the two nucleated bodies.

The blending of the pronuclei forms the segmentation nucleus containing the normal number of chromosomes. The cell is now capable of reproduction.

CHAPTER V

SEGMENTATION

I. KARYOKINESIS.

Segmentation refers to the cell-division taking place in the ovum, after the formation of the segmentation nucleus. It closely follows the law of karyokinesis. The cell division is regular and occurs in planes.

II. HOLOBLASTIC.

In mammals, the amount of yolk in the ovum is small and segmentation is equal throughout the ovum and is called holoblastic segmentation.

In amphibians there is a moderate amount of yolk and segmentation is unequally holoblastic.

III. MEROBLASTIC.

In birds and reptiles, there is a large amount of yolk and segmentation occurs in a small yolkless disc at one pole of the ovum. This form is known as meroblastic segmentation.

Note: The yolk (the yellow portion of the hen's egg for instance) is for the nourishment of the embryo.

CHAPTER VI

EMBRYONIC DEVELOPMENT

I. BLASTODERM.

In the chick the cells form a mass at the upper pole of the ovum, and from here gradually grow over and enclose the yolk.

II. BLASTULA.

In reptiles, the cells form a hollow sphere.

III. MORULA.

In mammals, the cells first form a solid mass. The outer cells become flattened and form the primitive ectoderm. Some of the innermost cells coalesce and are replaced by fluid. A cavity is thus formed called the blastodermic cavity, containing fluid, and into which projects a small mass of cells known as the inner cells.

CHAPTER VII

THE GERM LAYERS

Generally, there is a differentiation of cells in all classes, with a formation at first of two germ layers, and then three germ layers.

I. GASTRULA.

This is produced by an ivagination of the walls of the blastula forming a double-walled sac. The outer layer of cells is called the ectoderm or epiblast; and the inner, the endoderm, or hypoblast.

II. ARCHENTERON.

This is the cavity between the folds, and will later form the primitive alimentary canal.

III. BLASTOPORE.

The opening between the lips of the gastrula. It gradually becomes smaller and is situated in the median line on the dorsal surface of the embryo.

IV. MESODERM (OR MESOBLAST).

The middle germ layer, developing first at the median line and extending between the ectoderm and endoderm.

V. PRIMITIVE STREAK.

This is the line of fusion of the three germ layers in the middle.

VI. PRIMITIVE GROOVE.

A slight depression running along the middle of the primitive streak.

CHAPTER VIII

MORPHOLOGY OF THE GERM LAYERS

I. DESCRIPTION.

A. Ectoderm.

Composed of long, cylindrical, epithelial cells.

B. Mesoderm.

Composed of oval cells which later become irregular in shape with branched processes.

C. Endoderm.

Composed of flat epithelial cells.

II. EMBRYONIC TISSUES AND ORGANS.

The three germ layers, either singly or in combination, develop all the tissues and organs.

The origins of the principal organs and tissues are as follows:

A. Ectoderm.

1. Epidermis and its appendages (glands, hair, nails) and enamel of the teeth.
2. Epithelium of the nasal and oral cavities, and lower part of the rectum.
3. Nervous system and its derivatives; as well as the lens and the retina of the eye.
4. Chorion; fetal placenta; and amnion.

B. Mesoderm.

1. Connective tissues, including bone and teeth (except enamel).
2. All muscle tissue.
3. Circulatory organs (including blood and lymphatic systems).
4. Serous linings of the body cavities (meso-

thelium and endothelium).
5. Internal reproductive organs.
6. Kidneys and ureters.

C. Endoderm.

1. Epithelium of the digestive tract; digestive glands, including the pancreas and the liver.
2. Respiratory tract epithelium.
3. Epithelium of the bladder and urethra.
4. Epithelium of the thyroids; thymus; pharynx and Eustachian tubes.

CHAPTER IX.

FETAL MEMBRANES

I. INTRODUCTION.

The fetus is carried in a protective sac which is attached to the wall of the uterus, thus providing for its nourishment by the mother.

II. AMNIOTIC FOLDS.

Projections of the ectoderm and mesoderm which extend around the embryo. The anlagen of the amnion.

III. AMNION.

A closed sac, formed from the amniotic folds. It contains the liquor amnii in which the fetus floats.

IV. CHORION.

The more external of the two fetal membranes and containing villi. Part of the villi forms the fetal portion of the placenta.

V. PLACENTA.

The organ formed by the projection of chorionic villi into the mucous membrane of the uterus. It establishes communication between mother and child by means of the umbilical cord.

VI. ALLANTOIS.

A tube from the primitive intestinal tract to the chorion. Important in birds, because it carries nourishment from the yolk by means of blood vessels. In man it enters into the formation of the bladder.

CHAPTER X

EARLY DEVELOPMENT OF ORGANS

I. NEURAL CANAL.

At the median line, the ectoderm sinks in, to meet the endoderm. This forms two longitudinal ridges, called the medullary folds, and a groove called the medullary groove. The medullary folds finally meet, forming a closed tube, the neural canal, from which is developed the ventricles of the brain and the central canal of the spinal cord. The central nervous system is developed from the walls of the neural canal.

II. THE BRAIN VESICLES (Steps in Development).

A. The anterior end of the neural canal dilates forming a bulb, the primary brain vesicle.

B. From its sides, two small sacular projections grow, forming the optic vesicles.

C. Then posterior to the first vesicle, two more form, called the second and third primary brain vesicles.

D. The primary brain vesicle then constricts and forms two vesicles called the first and second secondary brain vesicles.

E. The second primary brain vesicle remains unchanged; but is now called the third secondary brain vesicle.

F. The third primary brain vesicle constricts, and forms two vesicles, called the fourth and fifth secondary brain vesicles.

CHAPTER XI

DEVELOPMENT OF THE BRAIN VESICLES

Following is a brief outline of structures developed from the secondary brain vesicles.

I. FIRST VESICLE (telencephalon or forebrain).
Develops the cerebral hemispheres; lateral ventricles; and olfactory bulbs.

II. SECOND VESICLE (diencephalon or tween-brain).
Develops the third ventricle; pineal gland; and optic thalami.

III. THIRD VESICLE (mesencephalon or mid-brain)
Develops the corpora quadrigemina and the aqueduct of Sylvius.

IV. FOURTH VESICLE (metencephalon or hind-brain)
Develops the cerebellum; pons Varolii; and fourth ventricle.

V. FIFTH VESICLE (myelencephalon or after-brain).
Develops the medulla oblongata and a continuation of the fourth ventricle connecting it with the central canal of the spinal cord.

CHAPTER XII

DEVELOPMENT OF THE EYE

I. OPTIC STALK.

The optic vesicles grow outward until they meet the ectoderm of the skin, causing prominences, over which the ectoderm becomes thickened.

The proximal part of the vesicle becomes constricted, forming the optic stalk.

II. OPTIC CUP.

The thickened ectoderm invaginates into the vesicle and becomes the anlage of the lens.

The wall of the vesicle thickens and becomes the anlage of the retina.

The developing lens pushes the invaginated wall inward, until it meets the peripheral wall of the vesicle, thus forming a cup. This process is called the "cupping of the primary optic vesicles."

An ingrowth of surrounding mesenchyme separates the anlage of the lens from the external ectoderm and an isolated hollow island of ectoderm results.

The central lining of the optic cup now becomes the developing nervous coat of the retina. The cells of the peripheral lining of the optic cup become pigmented and form the pigmented layer of the retina.

CHAPTER XIII

THE CHOROIDAL FISSURE AND THE OPTIC NERVE

I. FISSURE.

On the under surface of the optic cup there is a break in its continuity, due to the ingrowth of mesenchyme. This break is the choroidal fissure through which blood vessels enter. This fissure involves both the cup and stalk, continuing up to the seventh week.

II. ARTERY.

A large artery enters through the fissure. supplying the developing retina, and later becomes the central retinal artery.

The artery continues forward to the posterior surface of the lens and is known as the hyaloid artery.

III. RETINA.

A. Ganglion Layer.

The developing retina consists of two sets of cells.

The inner set is composed of neuroblasts (cells with a long process, which are the future ganglion cells of the central nervous system), which form the ganglion layer of the retina. Their axons are continued as the fibers of the optic nerve thru the optic stalk.

B. Rods and Cones.

The outer set are the neuro-epithelial cells (specialized epithelium, forming the perceptive elements of special sense), and form the layer of rods and cones.

C. Optic Chiasm.

The optic nerves converge and enter a thickening on the floor of the forebrain to form the optic chiasm.

CHAPTER XIV

RETINA AND CILIARY BODY

The neuro-epithelium develops into the rods and cones; but not completely so until just before birth. Some animals are born blind, the rods and cones not completely developing until after birth.

The anterior part of the retina thins out to form the ora serrata.

The proximal part of the ora serrata is thrown into folds to form the ciliary processes.

The ciliary body is completed by the entrance of mesenchyme which forms the stroma in which the ciliary muscle and blood vessels are developed.

The anterior end of the retina sends forth small projections which develop into the iris.

CHAPTER XV

THE LENS

At first the lens is a hollow vesicle. The epithelium on its anterior surface thins out and later becomes a single layer of cells, the lens epithelium.

The epithelium on the posterior surface elongates to form the lens fibers.

The fibers in the center become shorter and crowded in by the cells on the sides to form the "core" or nucleus of the lens.

By the end of the second month the mesenchyme grows around the lens forming a vascular tunic supplied by the hyaloid artery. In this way the lens capsule is formed, the anterior surface of which is called the membrana pupillaris.

CHAPTER XVI

DISTRIBUTION OF MESENCHYME

The remaining parts of the eye are formed from mesenchyme.

It surrounds the eye to develop the sclera; cornea; and choroid.

It enters the choroidal fissure and fills the interior of the optic vesicle to form the vitreous.

It enters into the formation of the ciliary body; iris; and vascular capsule of the lens.

[NOTE: The choroidal fissure usually closes by the end of the second month. If it fails to do so, congenital defects occur. If the retina and choroid are involved, the condition produced is coloboma chloroidae. If the retina and iris are affected, the condition is known as coloboma iridis. The pupillary membrane on the anterior surface of the lens usually disappears at the seventh month. If it persists, the condition is known as congenital atresia of the pupil.]

CHAPTER XVII

SCLERA; CHOROID; CORNEA; AND EYELIDS

I. SCLERA AND CHOROID.

At the sixth week the mesenchyme surrounding the retina develops two layers; the outer are consisting of dense white fibers and forming the sclera. The inner layer is loose, is very vascular and develops the choroid.

II. CORNEA.

The cornea is formed from a process of mesenchyme, which separates the outer surface of the lens from the external epithelium.

The mesenchyme splits, forming a cavity, the anterior chamber, into which grows the iris dividing it into two unequal cavities.

The anterior part of the split mesenchyme forms the cornea proper, and the endothelial layer. The ectoderm at the anterior of the cornea forms its epithelial surface.

III. EYELIDS.

The eyelids are formed by a folding of the integument on either side of the eyeball.

The folds meet and fuse about the third month and do not separate until a short time before birth.

The mesenchyme forms the tarsal cartilages; hair follicles and cilia; meibomian glands; and glands of moll. The orbicularis palpebrarum muscle is formed from mesoderm. The skin and conjunctiva are formed from ectoderm and the lacrimal gland is developed from an epithelial bud.

SECTION III

HYGIENE

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HYGIENE

CHAPTER I

FUNDAMENTALS

I. DEFINITION.

Hygiene may be defined as the science of health and its preservation.

II. PRESERVATION OF HEALTH.

Many people are in a state of ill health due solely to improper methods of living, and a correction of their errors often brings them health and more years of life.

Periodical health, dental and eye examinations should be the rule and not the exception if one wishes to preserve his health.

Old age is reached by one of two ways. Either the individual has observed the rules of right living or he has been endowed with a resistant constitution that withstood largely the attacks of disease. In the latter case even then old age may be more of a burden to the individual than life is worth, since many old people are just alive. Of course certain inherent conditions, such as cancer, prevent longevity.

III. RULES OF HEALTH.

According to Storey the fundamental rules of health are:-

A. "Remedy your defects."
B. "Eat right."
C. "Rest right."
D. "Exercise right."
E. "Bathe right."
F. "Excrete right."
G. "Avoid accidents."

CHAPTER II

GENERAL HEALTH AND OPTOMETRY

I. REFLEX CONDITIONS.

A knowledge of anatomy and physiology is necessary if the optometrist is going to understand the effects and reflexes produced by defective eyesight, or the effect of bodily ailments upon the eyes.

We find defective vision associated with epilepsy; headaches; chorea; neuralgia; flat-chests; drooping heads; crooked backs; eyestrains; optosis; etc. When lenses help to relieve the reflex conditions we are in a measure practising hygienic measures.

II. PERIODIC EXAMINATIONS.

The optometrist when first consulted by the patient should thoroughly inquire into the patient's general condition and habits. When necessary, urge your patient to consult his physician or dentist for remedying his defects. When a defect is discovered early, it is easier to remedy.

You should advise your patients to have annual or biennial eye examinations as the conditions warrant.

CHAPTER III

CORRECT EATING

There are many theories relative to eating right. But, according to most authorities the following rules obtain:-

I. Eat a good breakfast, because a goodly number of hours have elapsed between dinner and breakfast. Lunch lightly or if preferred it may be omitted. Eat a good dinner.

II. At the age of forty, one should begin to reduce his food consumption, especially if he has been in the habit of eating heavily.

III. Occupation of course is the best guide as to the kind and quantity of food needed.

IV. Meals should be eaten at regular hours. One should not eat when mentally disturbed, as food will not be easily digested.

CHAPTER IV

FATIGUE AND REST

I. FATIGUE.

The symptoms of a state of "normal fatigue" are:- lassitude; inefficiency of mind and body; and an inclination to rest and sleep. After a night of restful sleep, all functions should be fully restored. If one does not awaken in the morning feeling rested and fit, it means that he is carrying fatigue over from the previous day.

II. REST.

Each individual must determine for himself the number of hours he needs for complete rest. He should also make a practise of retiring at a particular hour.

The room should be well ventilated, and in winter, sufficient blankets should be used to avoid chilling.

CHAPER V

SYSTEMATIC EXERCISE

I. NECESSITY.

Exercise is necessary to cause the blood to carry off wastes rapidly and to bring nutrition to the tissues.

We all exercise more or less, but a few simple exercises persisted in at regular times, will be a means of promoting good health.

II. KIND.

Even active people exercise only a part of their bodies; therefore, exercises should be of such a nature as to affect as large a part of the body as possible.

Never exercise too soon before, or too soon after, meals.

CHAPTER VI

HYGIENIC BATHING

I. PURPOSE.

Bathing may serve two purposes. It may be used for the purpose of cleansing, or as in the case of the shower, for stimulation of the external tissues.

In the shower bath two admirable uses are found. Properly used the shower is a thorough cleanser, and a direct stimulant upon the skin and its vessels and nerve endings. Followed by a brisk rub with a rough towel, it imparts a feeling of glowing stimulation.

II. TIME.

Ordinarily baths should be taken in the morning for their stimulative effects.

Warm tub baths often induce sleep when other methods fail.

CHAPTER VII

HYGIENE OF THE EXCRETORY SYSTEM

I. PROPER FUNCTIONING.

In order that health may be maintained all organs of excretion must properly function. The skin, lungs, kidneys and bowels must be in a condition to respond to the demands made upon them.

A. Skin.

The skin by frequent bathing should be kept in a healthy condition.

B. Lungs.

The lungs must have an abundant supply of fresh air.

C. Bowels.

The intestines should be copiously evacuated at least once daily. Most cases of constipation are the result of irregular habits.

Exercise; regularity of habit; and proper diet; will clear up many cases of constipation.

D. Kidneys.

The kidneys should secrete and excrete freely. Plenty of water should be taken into the system so as to dilute the urine and prevent irritation of the kidneys.